DØnote 4546-Conf

Search for the Associated Production of Chargino and Neutralino in Final States with Three Leptons

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Searches have been performed for the trilepton decay signature from the associated production of the lightest chargino and the next-to-lightest neutralino in leptonic channels with (a) two electrons and a lepton, (b) an electron, a muon and a lepton (c) two muons and a lepton and (d) two like-sign muons. The searches use data taken with the DØ detector at the Fermilab Tevatron $p\bar{p}$ collider at a center-of-mass energy of 1.96 TeV corresponding to an integrated luminosity of 147 pb^{-1} to 249 pb^{-1}.

Preliminary Results for Summer 2004 Conferences

I. INTRODUCTION

Supersymmetry (SUSY [1, 2]) postulates a symmetry between bosonic and fermionic degrees of freedom and predicts the existence of a supersymmetric partner for each Standard Model particle. In R-parity-conserving minimal supersymmetric extensions of the Standard Model, the charged and the neutral partners of the gauge and Higgs bosons (charginos and neutralinos) are produced in pairs at $p\bar{p}$ colliders and decay into fermions and the Lightest Supersymmetric Particle (LSP).

This note describes the combination of four analyses which search for the associated production of the lightest chargino and the second-lightest neutralino in final states with three leptons and large missing transverse energy:

- final states with two electrons and a third lepton ("e+e+ℓ");
- final states with an electron a muon and a third lepton ("e+μ+ℓ");
- final states with two muons and a third lepton ("μ+μ+ℓ");
- final states with two like sign muons ("LS μ+μ").

The analyses are described in detail in [3], [4], [5] and [6].

As a guideline, the results are interpreted in the minimal supergravity model (mSUGRA) with chargino and neutralino masses mainly following the relation $m_{\chi_1^\pm} \approx m_{\chi_2^0} \approx 2m_{\chi_1^0}$. The points in mSUGRA parameter space considered here are characterized by low slepton masses, which lead to an enhanced leptonic branching fraction (typically 75% for the neutralino decay and 65% for the chargino decay). If the slepton and chargino masses are comparable, leptons can be produced either via virtual gauge bosons or slepton cascades. A set of representative parameter combinations (see Table I) has been simulated for chargino masses in the region near and beyond the LEP II chargino mass limit at 103 GeV [7].

II. RESULTS

Table II shows the number of events observed in data and the number of background events expected from Monte Carlo for the four analyses. The number of signal events expected for the four analysis channels for each reference point is summarized in Table III.

To avoid double-counting, signal selected by more than one analysis channel has been assigned to the channel with the best signal-to-background ratio and removed from the other channels. These overlaps amount to about 15% between the e+μ+ℓ and e+e+ℓ analyses, 10% between the e+μ+ℓ and μ+μ+ℓ analysis and 25% between the μ+μ+ℓ and the LS μ+μ analysis.

No evidence for SUSY has been found. The results are combined to extract limits on the total cross section using the likelihood ratio method (LEP CLs method [8]). Systematic and statistical errors, which are discussed in detail in the individual analysis descriptions and are summarized in Tables II and III, are taken into account in the combination including their correlations. The correlated error is dominated by the fully correlated luminosity uncertainty of 6.5%.

The resulting cross-section limits are shown in Fig. 1 as a function of the chargino mass. Beyond the reach of LEP chargino searches, the limit set by the combination of the four analyses is improving significantly on the DØ Run I result [9] and on the CDF Run I result [10]. The analysis excludes chargino masses below 97 GeV with comparable chargino, neutralino and slepton masses. The limit falls short of excluding cross sections beyond the LEP chargino limit predicted within minimal SUGRA. Sensitivity will be reached with 25% more data. The current results can

TABLE I: Properties of SUSY reference points (masses in GeV); All points have $\tan\beta$=3, $\mu > 0$ and $A_0 = 0$.

Pt	m_0 [GeV]	$m_{1/2}$ [GeV]	$m_{\chi_2^0}$ [GeV]	$m_{\chi^\pm}$ [GeV]	$m_{\tilde{\ell}_R}$ [GeV]	$m_{\tilde{\tau}1}$ [GeV]	$m_{\tilde{\nu}}$ [GeV]	$m_{\chi_1^0}$ [GeV]	BF(3lep)	$\sigma\times$ BF [pb]
1	68	160	98	93	98	97	115	52	0.44	0.47
2	72	165	102	97	102	101	120	57	0.44	0.39
3	76	170	106	101	106	105	126	59	0.39	0.32
4	80	175	110	105	110	109	131	62	0.37	0.27
5	84	180	114	110	114	113	137	64	0.37	0.21
6	88	185	118	114	118	117	142	67	0.38	0.18
7	106	205	135	132	136	135	165	72	0.31	0.07

TABLE II: Number of candidate events observed and background events expected in the four analysis channels

Analysis	Data	Total Background
e+e+ℓ	1	0.68 ± 0.40 ± 0.32
e+μ+ℓ	0	0.29 ± 0.33 ± 0.02
μ+μ +ℓ	1	1.83 ± 0.40 ± 0.21
LS μ+μ	1	0.13 ± 0.06 ± 0.02

TABLE III: Number of signal events expected for the four analysis channels after subtracting overlaps

Analysis	Pt1	Pt2	Pt3	Pt4
e+e+ℓ	2.33±0.15±0.11	2.21±0.11±0.09	1.83±0.08±0.08	1.65±0.07±0.09
e+μ+ℓ	1.84±0.08±0.09	1.51±0.07±0.08	1.25±0.06±0.07	1.18±0.05±0.06
μ+μ +ℓ	1.35±0.07±0.14	1.28±0.06±0.14	1.12±0.04±0.12	1.06±0.04±0.12
LS μ+μ	0.42±0.03±0.03	0.39±0.03±0.03	0.36±0.03±0.03	0.37±0.03±0.03

Analysis	Pt5	Pt6	Pt7
e+e+ℓ	1.43±0.05±0.09	1.39±0.06±0.08	0.70±0.03±0.02
e+μ+ℓ	1.00±0.04±0.05	0.86±0.03±0.05	0.44±0.02±0.02
μ+μ +ℓ	0.80±0.03±0.09	0.70±0.03±0.07	0.34±0.01±0.04
LS μ+μ	0.25±0.02±0.02	0.24±0.02±0.02	0.13±0.01±0.01

be used though to constrain more generic SUSY models with compatible mass hierarchies in the slepton, chargino and neutralino sector. By dropping the sfermion mass universality, for example, squarks can be heavy while sleptons remain light. Within this szenario, chargino masses below 111 GeV are excluded by the present analysis (see Fig. 1).

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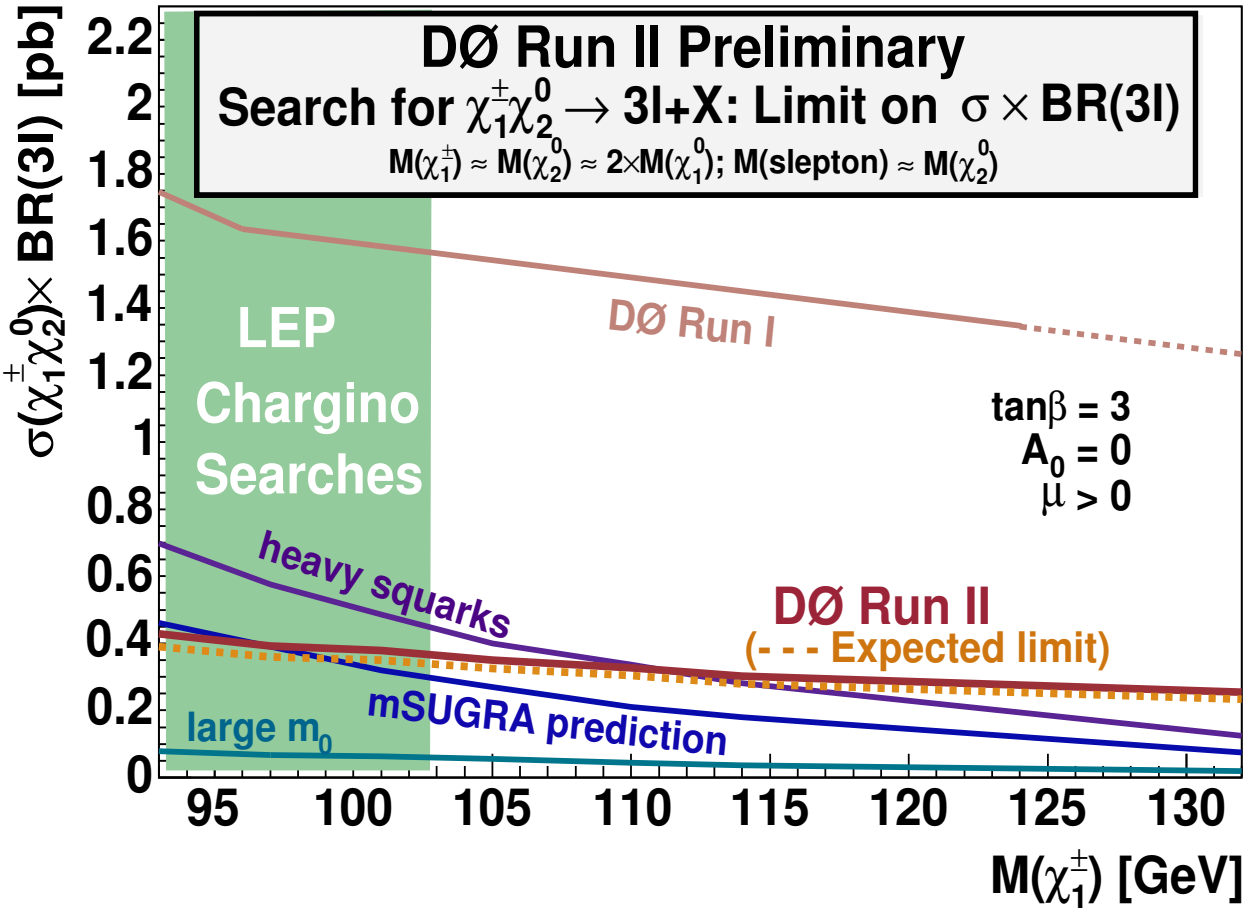

FIG. 1: Limits on the total cross section for associated chargino and neutralino production with leptonic final states set by DØ in Run I (top line) and in this analysis (second from top) in comparison with the expected limit (dashed line). Three model lines are plotted as a reference. The top line corresponds to the signal cross section × leptonic branching fraction predicted for models with heavy squark masses and low slepton masses. The middle line corresponds to the signal expectation for low slepton masses in mSUGRA and the bottom line describes the signal expectation for large m_0 with the chargino and the neutralino decaying via virtual gauge bosons. Chargino masses below 103 GeV are excluded by direct searches at LEP.